

CONSERVATION MANAGEMENT PRACTICE

Emission Reduction Calculation Methodology for Combined Operations

Description

The practice “Combined Operations” means to combine pieces of equipment or operations to perform several operations during one pass over the field. The emissions come from the soil being disturbed by tractors and their implements.



Reducing emissions from soil disturbances can be achieved by reducing the number of passes over the field. One example is combining two practices such as cane cutting or disking, or flat furrowing into one single pass. This reduces soil disturbance with the elimination of passes.

It is possible to estimate the emissions using California Air Resources Board (ARB) emission factors and the reduction from combined operations using a study performed by Coates¹. The control effectiveness of this practice would have to be further evaluated through research studies, quantitative analysis, or literature search.

Applicable Crops

This practice can be used on all crops where combined operations are feasible. These include the following crop categories: corn/grain and silage, cotton, alfalfa, vegetables/tomatoes, melons, sugar beets, tree fruit, grapes, dry beans/cereal grains/safflower/wheat/barley, onion/garlic, and nut crops.

CMP Category

This practice is applicable to these CMP Categories: Land Preparation and Harvest.

Emission Factor

ARB compiled several emission factors for land preparation and harvest activities per crop type; see Tables 1 and 3. The development of the emission factors is described in ARB’s Methodologies for Emission Inventory Source Category, sections 7.4 and 7.5 for agricultural operations.

The emission factors were based on operation specific emission factors developed by the University of California, Davis^{2,3}, and on background

information such as the number of field passes and crop calendars (seasons) compiled with the assistance of farmers and agricultural experts.

Control Efficiency

Based on Appendix B of a technical supporting document compiled by Arizona Department of Environmental Quality¹, the control efficiency is 35% for combining land preparation operations and 43% for harvest operations. Their assumptions are based on a 1994 study by Coates that identifies the total PM10 emissions generated for five different cotton tillage systems. Four of the systems evaluated combined shredding, disking, and mulching. A minimal control efficiency of 35% to a maximum 50% (average 43%) was determined to be possible. It was also assumed that the control efficiency is transferable to other crop types.

Emission Reduction Calculation for an Agricultural Parcel

A. Land Preparation

1. Option 1 (Use when the number of pass reduced is available)

$$\text{Emission Reduction}_{(\text{tons/year})} = \frac{\left[\sum (\text{Pass} \times \text{Emission Factor}_{(\text{lbs/acre-pass})}) \right] \times \text{Acreage}_{(\text{acre/year})}}{2000_{(\text{lbs/ton})}}$$

Where:

Pass = number of field passes reduced per acre per year
 Emission Factor = emission factor for type of pass (operation specific), see Table 1
 Acreage = parcel acreage for CMP

Example:

$$\text{Emission Reduction} = \frac{\left[(1 \text{ disking pass} \times 1.2_{(\text{lbs/acre-pass})}) + (1 \text{ weeding pass} \times 0.8_{(\text{lbs/acre-pass})}) \right] \times 100_{(\text{acre/year})}}{2000_{(\text{lbs/ton})}}$$

$$\text{Emission Reduction} = \frac{(2_{(\text{lbs/acre})}) \times 100_{(\text{acre/year})}}{2000_{(\text{lbs/ton})}}$$

Emission Reduction = 0.10 tons/year

2. Option 2 (Use when the number of pass reduced is not available)

$$\text{Emission Reduction}_{(\text{tons/year})} = \frac{[\text{Acreage}_{(\text{acre/year})} \times \text{Emission Factor}_{(\text{lbs/acre})} \times \text{Control Efficiency}_{(\%)})}{2000_{(\text{lbs/ton})}}$$

Where:

Acreage = parcel acreage for CMP

Emission Factor = land preparation emission factor (crop specific), see Table 2

Control Efficiency = CMP efficiency to reduce emissions, 35%

Example for Corn:

$$\text{Emission Reduction} = \frac{[100_{(\text{acre/year})} \times 6.9_{(\text{lbs/acre})} \times 35_{(\%)})}{2000_{(\text{lbs/ton})}}$$

$$\text{Emission Reduction} = \frac{241.5_{(\text{lbs})}}{2000_{(\text{lbs/ton})}}$$

Emission Reduction = 0.12 tons/year

B. Harvesting

$$\text{Emission Reduction}_{(\text{tons/year})} = \frac{[\text{Acreage}_{(\text{acre/year})} \times \text{Emission Factor}_{(\text{lbs/acre})} \times \text{Control Efficiency}_{(\%)})}{2000_{(\text{lbs/ton})}}$$

Where:

Acreage = parcel acreage for CMP

Emission Factor = harvest emission factor (crop specific), see Table 3

Control Efficiency = CMP efficiency to reduce emissions, 43%

Example for Corn:

$$\text{Emission Reduction} = \frac{[100_{(\text{acre/year})} \times 1.7_{(\text{lbs/acre})} \times 43_{(\%)})}{2000_{(\text{lbs/ton})}}$$

$$\text{Emission Reduction} = \frac{73.1_{(\text{lbs/yr})}}{2000_{(\text{lbs/ton})}}$$

Emission Reduction = 0.04 tons/year

Sources of Information

1. Technical Support Document for Quantification of Agricultural Best Management Practices, Final Report, URS Corporation. Prepared for Arizona Department of Environment Quality, June 2001.

2. California Air Resources Board, *Section 7.4—Agricultural Land Preparation*. Methods for Assessing Area Source Emissions. January 2003.
3. California Air Resources Board, *Section 7.5—Agricultural Harvest Preparation*. Methods for Assessing Area Source Emissions. January 2003.

Table 1: Emission Factors² for Type of Land Preparation Operation

Land Preparation Operation	Emissions Category	Emission Factor (lbs PM10/ acre-pass)
Chisel	Discing	1.2
Disc	Discing	1.2
Disc & Furrow-out	Discing	1.2
Disc & Roll	Discing	1.2
Finish Disc	Discing	1.2
Harrow Disc	Discing	1.2
Land Preparation, Gen.	Discing	1.2
Mulch Beds	Discing	1.2
Plow	Discing	1.2
Post Burn/Harvest Disc	Discing	1.2
Stubble Disc	Discing	1.2
Unspecified Operation	Discing	1.2
3 Wheel Plane	Land planing	12.5
Float	Land planing	12.5
Land Plane	Land planing	12.5
Laser Level	Land planing	12.5
Level	Land planing	12.5
Level (new vineyard)	Land planing	12.5
Plane	Land planing	12.5
Subsoil	Ripping	4.6
Subsoil-deep chisel	Ripping	4.6
Bed Preparation	Weeding	0.8
List	Weeding	0.8
List & Fertilize	Weeding	0.8
Listing	Weeding	0.8
Roll	Weeding	0.8
Seed Bed Preparation	Weeding	0.8
Shape Beds	Weeding	0.8
Shape Beds & Roll	Weeding	0.8
Shaping	Weeding	0.8
Spring Tooth	Weeding	0.8
Terrace	Weeding	0.8

Table 2: Emission Factors² for Land Preparation Operations

Crop Categories	Land Preparation Emission Factor (lbs PM10/acre/yr)
Alfalfa	4
Corn grain and silage	6.9
Cotton	8.9
Dry Beans, cereal grains, safflower, wheat, and barley	4.45
Grapes	1.82
Nut crops	3.13
Onions and garlic	6.5
Tree Fruit	0.07
Sugar Beets	22.8
Vegetables, tomatoes, melons, and other	9.05

Table 3: Emission Factors³ for Harvest Operations

Crop Category	Harvest Emission Factor (lbs PM10/acre/yr)
Alfalfa	0.24
Corn grain and silage	0.43
Cotton	3.37
Dry Beans, cereal grains, safflower, wheat, and barley	3.45
Grapes	0.17
Nut crops	36.50
Onions and garlic	1.68
Tree Fruit	0.14
Sugar Beets	1.69
Vegetables, tomatoes, melons, and other	0.23